

PHASE ENHANCED ABSORPTION

A Novel Method To Enhance
Absorption Rate

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INTRODUCTION

- Physical absorption

the gas component being absorbed is simply dissolved in the liquid absorbent.

CO₂ dissolves into Water, Propylene Carbonate, Methanol, etc.

- Chemical Absorption

there is a chemical reaction between the gas component being absorbed and a component in the liquid to form a compound.

Hot Potassium Carbonate Solution,
Aqueous Alkanolamines, etc.

Chemical Absorption

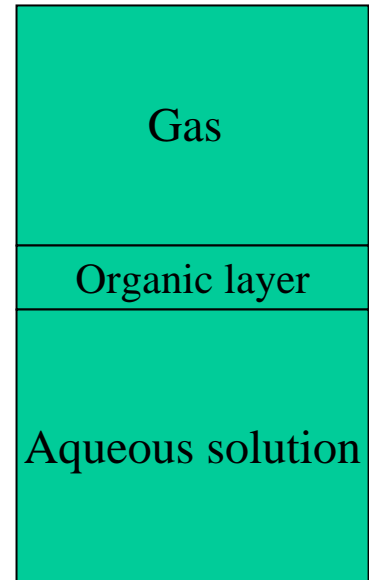
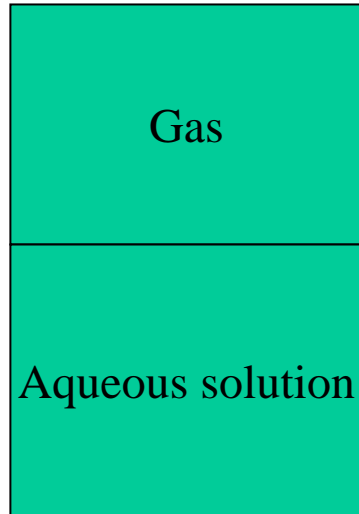
- Advantage
 - 1) enhancing the absorption rate
 - 2) increasing carrying capacities for gas components
- Disadvantage

chemical reaction causes difficulty for the release of the gas components from liquid

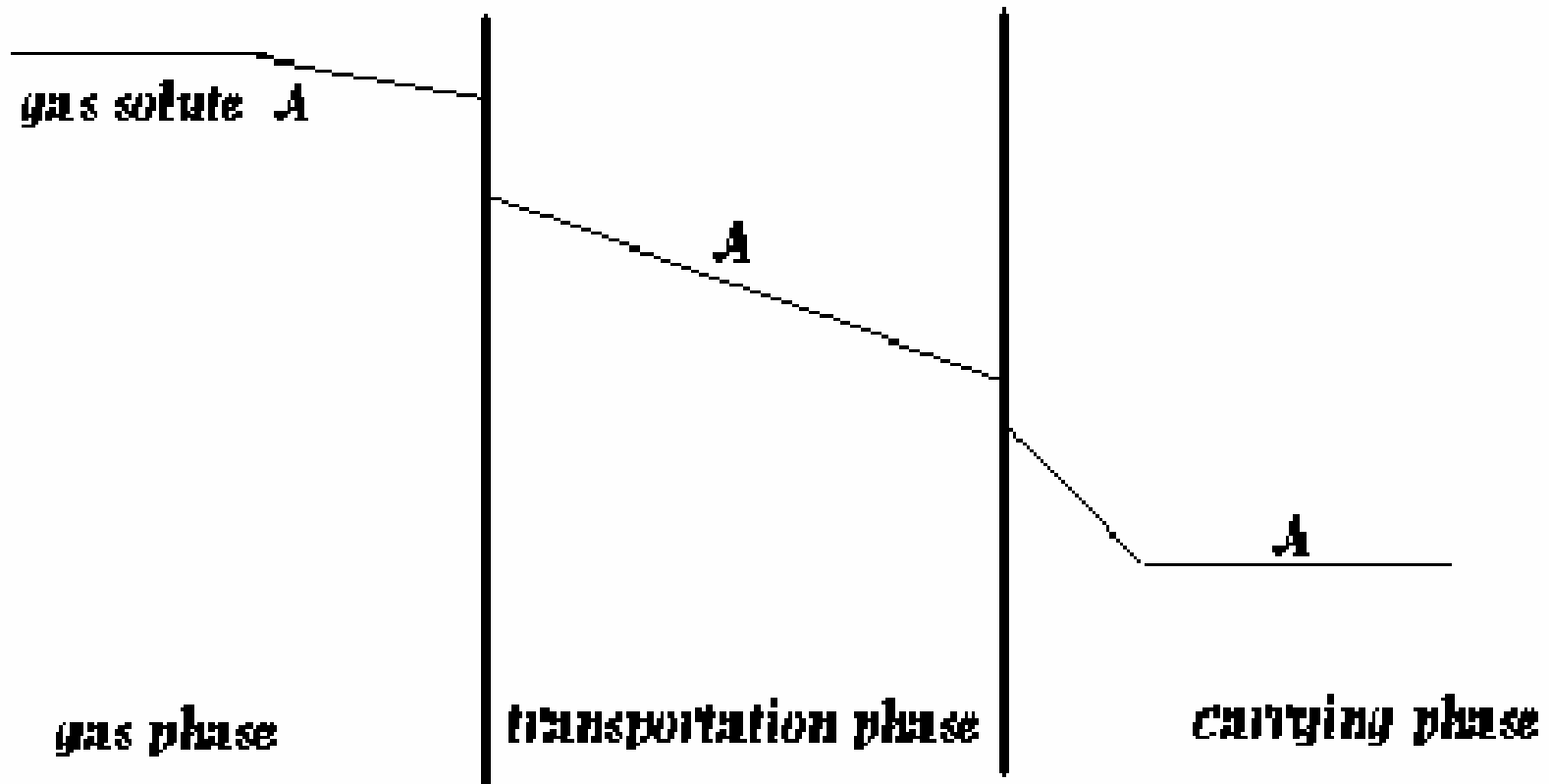
What is Phase Enhanced Absorption?

In phase enhanced absorption, more than one liquid phases were involved in the absorption process. One of the liquid phase was called as carrying phase, in which gas solute will be finally accumulated. Another liquid phase is known as transportation phase. The transportation phase only plays the rule for the transportation of the gas solute from gas phase to carrying phase and for the increase of absorption rate. In phase enhanced absorption, the absorption rate is enhanced by the transportation phase.

What is Phase Enhanced Absorption?



MASS TRANSFER MODEL



MASS TRANSFER EQUATION

- Physical Absorption

$$N_A = k_1 (C_A^* - C_A)$$

- Chemical Absorption

$$N_A = E_R k_1 (C_A^* - C_A)$$

- Phase Enhanced Absorption

$$N_A = E_P k_1 (C_A^* - C_A)$$

STIRRING CELL

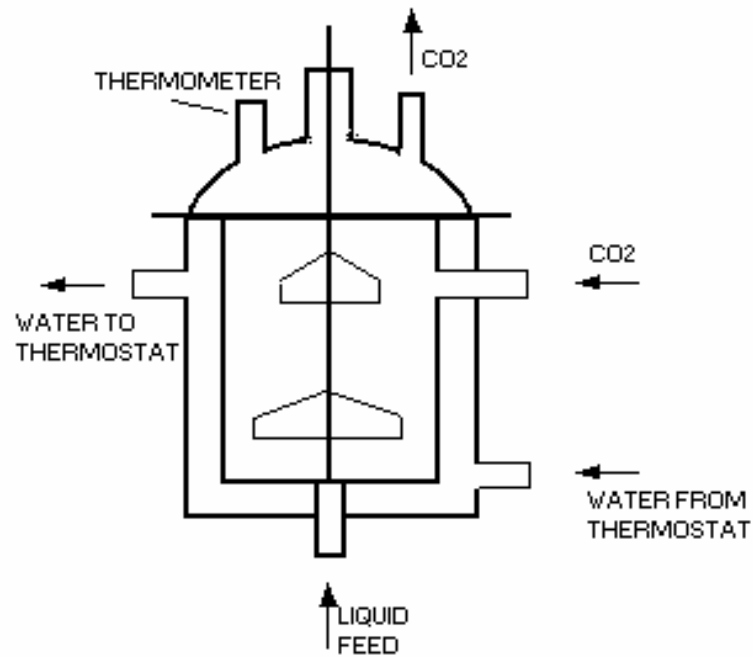


FIGURE 1 STIRRING CELL

EXPERIMENTAL FLOW CHART

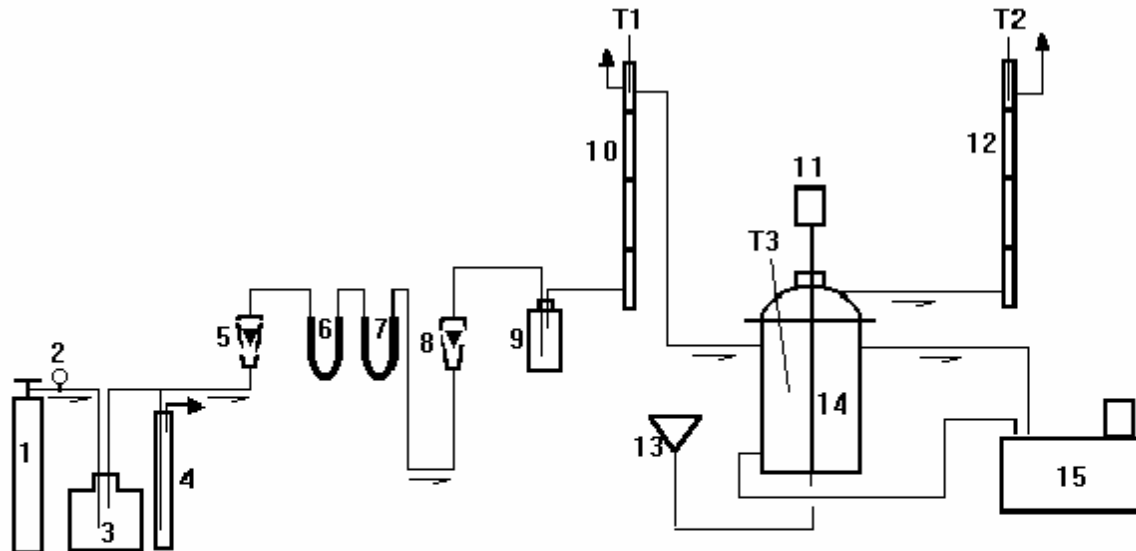


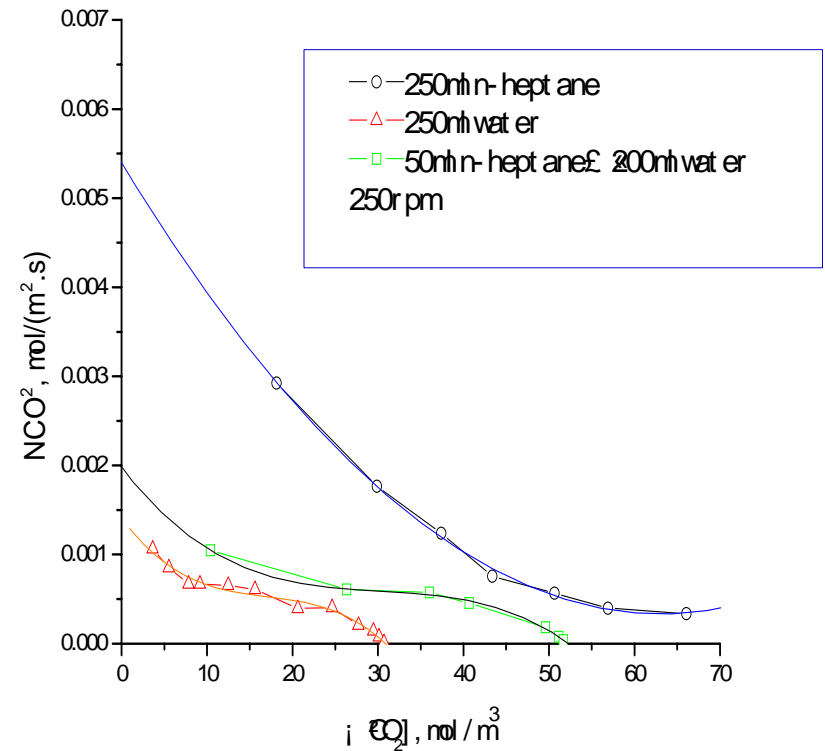
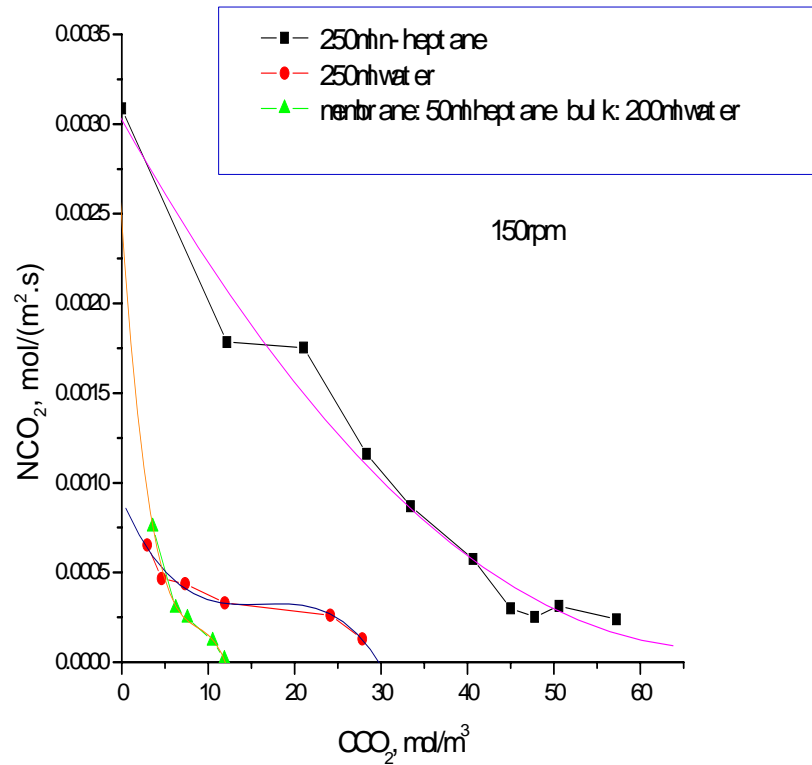
FIGURE 2 EXPERIMENTAL APPARATUS

1 - CO₂ CYLINDER; 2 - REGULATOR; 3 - BUFFER BOTTLE; 4 - PRESSURE STABLE TUBE;
 5, 8 - ROTATING FLOW METER; 6 - SILICON GEL U TUBE; 7 - ACTIVE CARBON U TUBE;
 9 - SATURATOR; 10, 12 - FOAM FILM FLOW METER; 11 - MOTOR; 13 - LIQUID FEED FUNNEL;
 14 - STIRRING CELL; 15 - THERMOSTAT; T1, T2, T3 - THERMOMETER

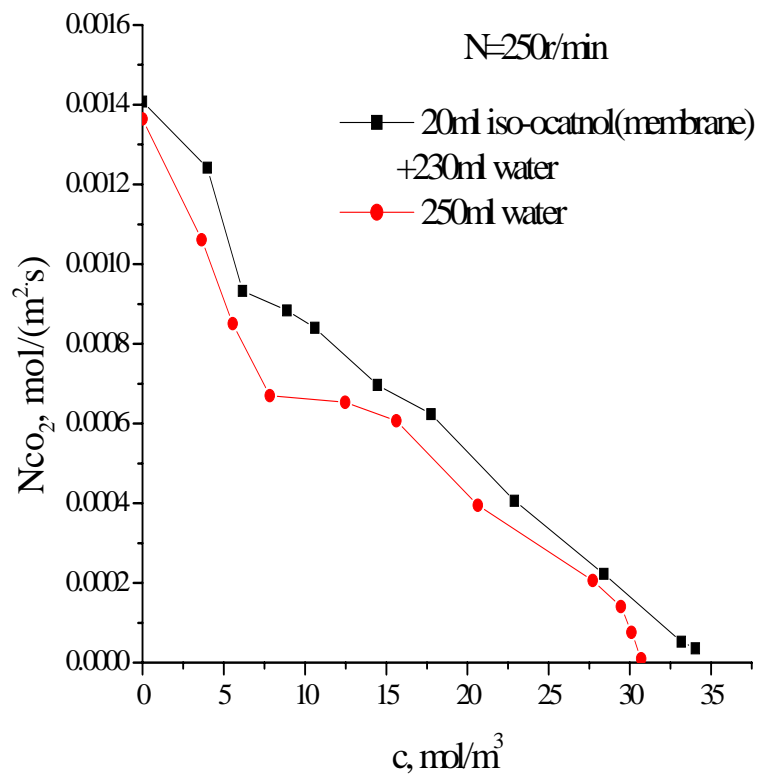
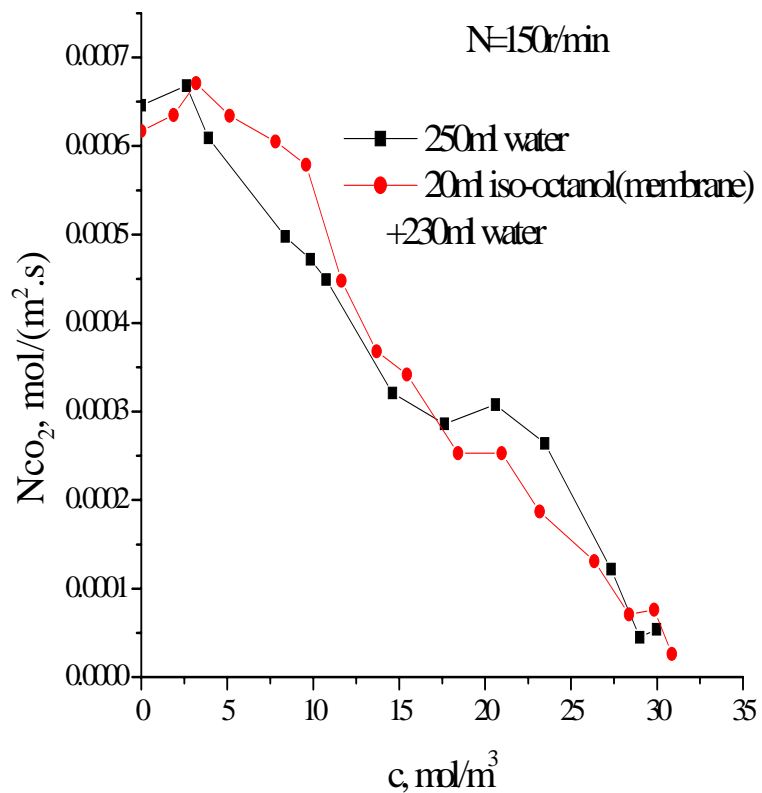
RESULTS AND DISCUSSION

- **Following experimental results prove that CO₂ absorption rate is enhanced by PHASE**

CO₂-water system and CO₂-water-n-haptane layer system

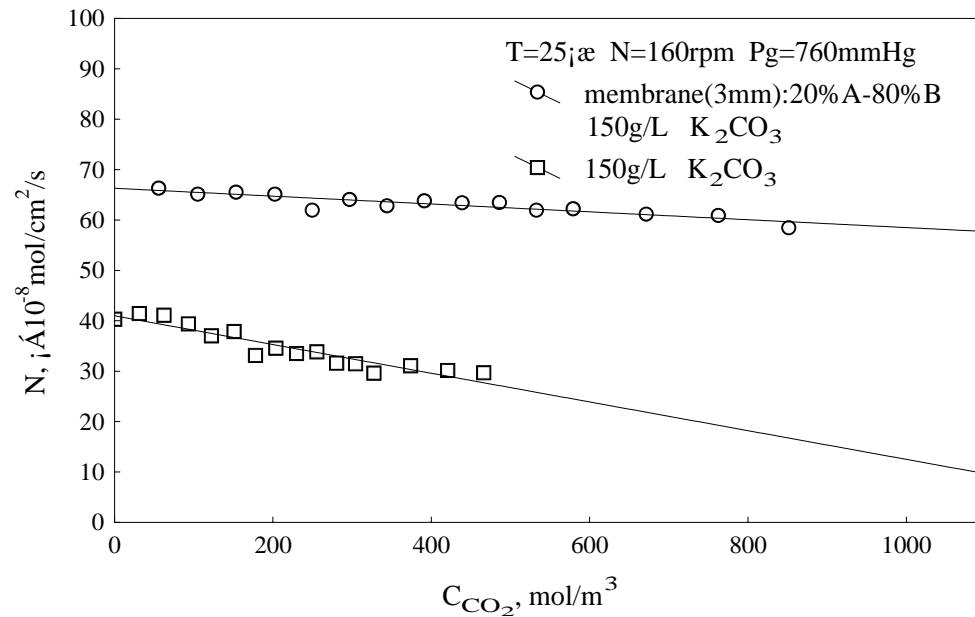


CO₂-water system and CO₂-water-isooctanol system



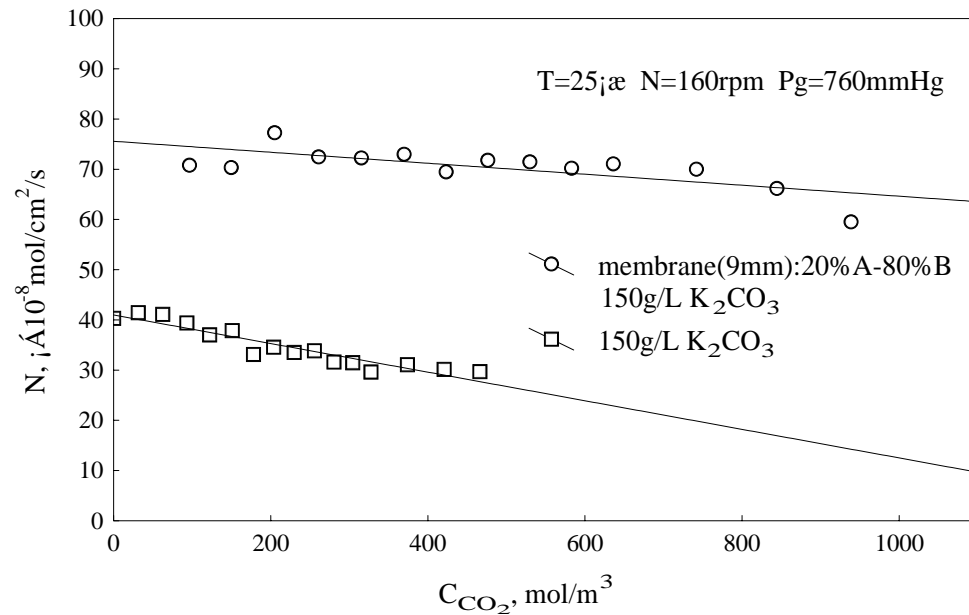
CO₂-potassium carbonate aqueous solution

CO₂-potassium carbonate aqueous solution-organic layer (membrane 3 mm)



CO₂-potassium carbonate aqueous solution

CO₂-potassium carbonate aqueous solution-organic layer (membrane 9 mm)



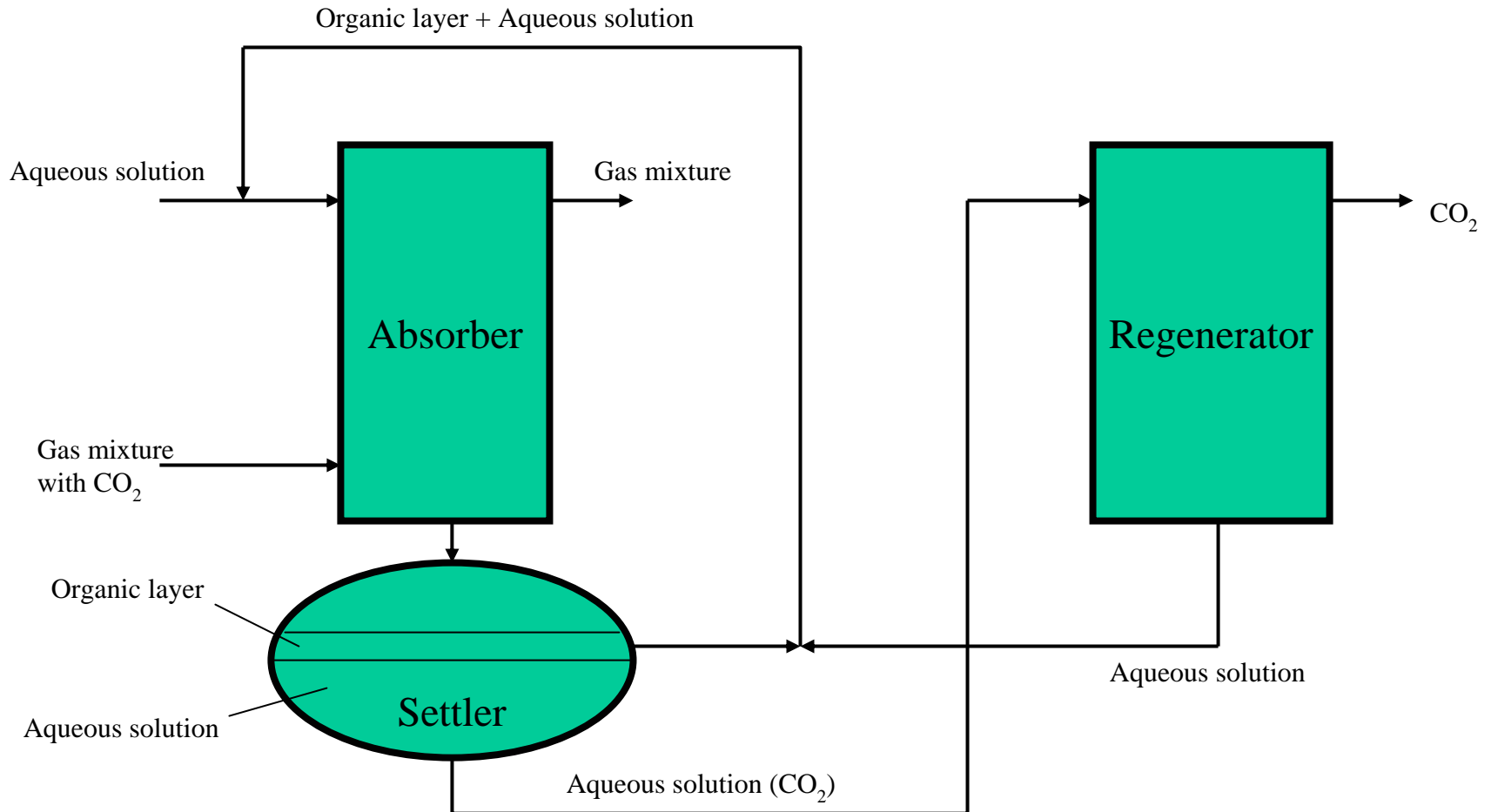
MECHANISM

- Mass transfer resistant between the interface of gas and liquid is much higher than that between the interface of liquid and liquid
- Mass transfer resistant between the interface of gas and organic layer is lower than that between the interface of gas and aqueous solution
- The transportation layer (organic layer) delivers CO₂ from gas phase into water phase and enhances the absorption rate as long as the sufficient mass transfer (agitation) between two liquid phases is provided.

CONCLUSION

- Organic layer can increase the absorption rate as long as sufficient mass transfer in liquid (agitation) is provided
- Organic layer plays the role of transportation of CO_2 from gas to aqueous solution
- However, the enhanced factor is highly depended on the liquid mass transfer coefficient (agitation)

APPLICATION



WHAT IS NEXT?

- Seeking the application of phase enhanced absorption in CO₂ separation from flue gas